DENSITY OF COMPACTED BITUMINOUS MIXTURES — NUCLEAR METHOD

(An Arizona Method)

Scope

1. This test method provides a procedure for field determination of the in-place density of compacted layers of bituminous mixtures by the use of nuclear apparatus.

Apparatus

2. The apparatus shall consist of the following:

(a) Nuclear moisture-density gauge. Any suitable device built within a single integrated housing, or consisting of a scaler and a probe which are connected together by a special electronic cable. These gauges normally include certain moveable parts or accessories which can be arranged to perform two different modes of tests for bulk density known as backscatter and direct transmission, and also a test of moisture content.

(b) The standardizing and accessory equipment provided with the gauge by its manufacturer and bearing the same serial number, including as a minimum, the specially built reference standard, a copy of the operating instructions, a copy of the current calibration charts, and a device for testing and smoothing the planeness of the test surface.

NOTE: *To be current, the calibration of gauges and development of calibration charts shall be the result of a calibration procedure performed within the preceding 12 months by Materials Section.*

Standardization

3. At the beginning of each inspection shift the apparatus shall be standardized and checked for proper operation as follows:

(a) The reference standard shall be placed outdoors on a generally level and dry area of pavement or firm soil. This location must be within the length and right-of-way of the project to be inspected, at least 10 feet from any vehicle, tree or other vegetation, large heavy object or building, or great change in surface slope, and at least 50 feet from any other gauge.

(b) The top surface of the reference standard and the bottom and other surfaces of the gauge which mate with it shall be wiped clean of any dirt, dust, bituminous material, or other foreign matter which might interfere with a firm and close seating of one upon the other.

(c) The gauge shall be seated upon the reference standard in the position described in the manufacturer's instructions, and checked to be sure there is no wobble or gap between their surfaces. The gauge switches are turned to the "On" or "Standby" and "Calibrate" positions, whichever are provided, and allowed to warm up for at least 15 minutes before any readings are taken.

NOTE: *If desired, this warm-up operation may begin earlier, before or during the time the gauge and the reference standard are being cleaned and placed.*

(d) After the warm-up period is completed, standard counts are obtained with the source rod and other controls in the positions recommended by the manufacturer, for both moisture and density. All of the values obtained shall be recorded permantently and no values discarded or replaced by a recount simply because of their apparent variation from the others. The number of standard counts and the method of reducing them to a single value to be used as the standard count for the following shift shall be in accordance with the manufacturer's instructions; provided it is obtained by averaging at least 3 separate one-minute readings.

NOTE: *If a gauge is used which has the capability of providing a density reading, the last value obtained for the moisture and density standard count is stored in memory by the gauge. This value should be recorded by the operator as the standard count for the following shift.*

(e) Before any standard count is put to use, it shall be checked to determine whether it is within acceptable limits. It shall be considered to be acceptable if it varies by less than one percent from the average of the standard counts for that gauge which were obtained during the three previous days on which it was used. If it is not within this acceptable range, the reference standard shall be moved at least 50 feet to another site with equal or better spacing from interfering objects, the gauge and reference standard shall be cleaned more thoroughly, and the same procedure and number of standard counts taken again with careful attention to the positioning of the controls, particularly the seating of the source rod in its latch. Normally the new value will be within the above acceptable limits, but if not, it will be used if it is within one percent of the first value and not more than two percent from the three day average. If outside of these limits, the gauge batteries shall be re-charged and contact made with the office given authority for maintenance of the gauge.

(f) After an acceptable value for the standard count has been obtained, the gauge shall not be turned off until after all tests planned during the shift have been completed. Instead, it shall be left operating in the "On" or "Standby" condition as recommended in the manufacturer's instructions. If it is found that further tests are needed, after it has been turned entirely off for more than five minutes, the entire standardization process shall be repeated first.

Adjustments to Values from Calibration Charts

4. It will be necessary to adjust the values for density obtained from the calibration charts. This adjustment will be made by applying a correction factor, as determined in the following paragraphs. A new correction factor shall be determined whenever there is a change in mix design or in a source of aggregates. A new factor shall also be established for any major change in the underlying material, as from compacted subgrade to an older layer of bituminous concrete.

(a) The asphaltic concrete shall be laid over an area of the applicable underlying material at least 500 square yards and compacted in a layer of specified thickness. Immediately after compaction has been completed, two one-minute readings for density in the backscatter mode shall be taken at a minimum of seven random locations within the area, following the surface preparation and other procedures in paragraph 4 (b). The precise places shall be randomly selected and shall be recorded.

(b) Normally the preparation of the surface for taking readings at each place shall not include the removal of any material for the purpose of making it more smooth, except that particles which are completely unattached and merely lying loose on top of the compacted and bound mixture shall be brushed away. Unless it is demonstrated that the use of sand is unnecessary, not more than one pound of dry fine sand (minus No. 8 mineral aggregate) shall be spread over each place and then scraped away with a straightedge so that the mixture is visible over the majority of the surface. A straightedge shall be used to check each place for surface variations and the gauge shall be turned to set in the way that is most nearly plane. The gauge shall then be tested by hand for firm seating and by eye for full contact around its edges. Each time the gauge is lifted to obtain another reading its bottom surface shall be inspected and any asphalt or other materials cleaned from it.

(c) The two one-minute readings at each location shall be obtained by rotating the gauge 180°. Each reading shall be recorded at once. Obvious error in surface preparation, improper equipment operation or effects of the underlying material may be reason for evaluating and/or discarding readings if they vary significantly from the other readings (greater than ±8 lbs/cu. ft. variance from the average density obtained).

NOTE: *In order to achieve a minimum of seven acceptable test locations, additional randomly selected locations shall be chosen to replace any discarded values.*

(d) The average of all acceptable count readings shall be calculated and recorded. Using the average obtained, a density to the nearest 0.1 pounds per cubic foot is found from the calibration chart.

NOTE: *If a gauge is used which has the capability of providing a density reading, the average reading for density shall be determined to the nearest 0.1 pounds per cubic foot.*

(e) After the material has cooled sufficiently, a core shall be drilled from each of the same places where the acceptable nuclear density readings were taken. Each core shall be carefully trimmed or sawed to remove all materials except layers of the mixture for which the calibration is being performed. The specific gravity of each core shall then be obtained in accordance with AASHTO T 166, Method C. The average specific gravity of all cores shall then be calculated, and converted to density to the nearest 0.1 pounds per cubic foot and recorded.

NOTE: *Until the specific gravity is determined by AASHTO T 166, Method C, a suitable estimated value for specific gravity may be used.*

(f) The average density obtained in paragraph 4 (d) is compared to the average density obtained in 4 (e) and their difference shall be recorded as the adjustment which is to be applied to densities obtained in the future tests on that material. This difference shall be added to or subtracted from the test density, respectively, as the density from 4 (e) is larger or smaller than that from 4 (d).

Individual Nuclear Density Measurements

5. (a) At each location where a nuclear density test is required the following procedure shall be used to obtain a test value to compare to the specification density. The test shall be made immediately after completion of compaction on the area or lot of material concerned.

(b) The surface preparation and other procedures in paragraph 4 (b) shall be followed. At each location where a test is required, two one-minute readings for density in the backscatter mode shall be taken. The two one-minute readings shall be obtained by rotating the gauge 180°. Each reading shall be recorded at once. Obvious error in surface preparation, improper equipment operation or effects of the underlying material may be reason for evaluating and/or discarding some readings if they vary significantly from the other readings (greater than ± 8 lbs per cu. ft. variance from the average density obtained).

NOTE: *Additional randomly selected locations shall be chosen to replace any discarded values.*

(c) The two one-minute readings shall be averaged and recorded. The average shall constitute one test value. The location of test shall be recorded by station and centerline offset.

(d) Each test value, shall be converted to count ratio by dividing it by the appropriate standard count, and then to pounds per cubic foot by reference to the calibration charts. (If the gauge used has the capability of providing a density reading, the density shall be determined directly from the gauge.) To obtain a test result to compare to the specification density, this test

value in pounds per cubic foot shall be adjusted as described in paragraph 4 (f) and all of these values shall be recorded. The density values shall be recorded to the nearest 0.1 pounds per cubic foot.

Precautions

6. (a) Except when actually in use performing tests, the gauge and its accessories are to be kept within the A.R.R.A. (Arizona Radiation Regulatory Agency) approved carrying case, to protect it from damage and to provide better radiation shielding for persons in its vicinity. When being transported in a vehicle in particular, it should be in the carrying case which should be firmly tied or fastened in place. In a pick-up truck the gauge should be secured in the back; in a sedan the gauge should be placed in the trunk; in a station wagon or van the gauge should be secured as far away as possible from the passengers.

(b) The health and safety of all operators is under the jurisdiction of the District Radiation Safety Officer who will initiate and administer all safety procedures. Usually those will include the provisions of a film badge to the operator and to any other persons who spend a comparable amount of time in the same close proximity to the gauge. The film badge is to be worn at all times when working with or near the gauge, but at other times is to be kept at least 10 feet away from it, and certainly not stored in or on the carrying case.